Confidential Claim Retracted

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ATTACHMENT I

VEGETATION MONITORING & WASTEPILE SLOPES JACKPILE-PAGUATE MINE

INTRODUCTION

This document addresses vegetation monitoring and wastepile slopes for the Jackpile-Paguate Mine. The discussion is designed to provide:

- o quantitative and qualitative vegetation data on both the reference and reclaimed areas;
- o information which will be used to judge success of revegetation;
- o consistent sampling techniques so that data are comparable from year to year; and
- o requirements for period of liability and wastepile slopes.

Liability Period

The liability period of Anaconda will be no less than 10 years. The minimum 10-year liability period is set to ensure the establishment of an effective vegetation cover (plant community) that will be capable of succession or able to sustain itself. Discussions with experts reveal that any disturbed ecosystem requires many years to recover and a 10-year period is scientifically not sufficient to determine if an ecosystem has recovered. Moreover, federal and state regulations stipulate a 10 year period of liability (30 CFR 816.116(b)(1)(ii), Colo. Rev. Stat. Sec. 34-32-116(1)(r), Mont. Rev. Codes Ann. Sec. 82-4-235, and Wyo. Stat. Sec. 32-11-403d(b)).

Procedures

All vegetation sampling should be done randomly in order to allow all species an equal opportunity of occurring at a given sampling location. Such randomization is needed so an unbiased estimate of the mean and variance of vegetation characteristics can be made for statistical comparisons. If transects are used, systematic sampling may be used within the transects. However, for statistical purposes, the transect is treated as an individual observation. Systematic sampling may reduce the variability of the data set, but may also require a greater expenditure of time to collect a sufficient number of observations. Representative or typical area samples will not be acceptable.

Vegetation quadrats or transects may be located by drawing a grid system (x- and y- axis) on a sufficient size map for each sampling area. Axis length depends upon the size of the area considered. Transect origins or quadrat points are located within the grid system using numbers selected from a random numbers table. If transects are used, random numbers are also used to determine the compass direction in which the transect will run.

Field sampling should be conducted in order to allow both the reclaimed and the representative reference areas to be sampled at the same time for comparability. Sampling should preferably be conducted from July through September and periodically through the liability period to monitor progress toward success of revegetation.

In order to maintain consistency in sampling and to be able to correlate vegetation data, techniques should be selected and used throughout the liability period.

Cover Measurement. Cover is a measure of the amount of ground surface covered by plant species, litter, etc. and expressed by the vertical projection of plant parts (i.e. basal area). Measurement of vegetation cover can be accomplished by several techniques such as ocular estimation, belt transect, line intercept and point methods. The type of cover measured can either be ground or basal cover. Data recorded should include litter, rock, bare ground, and vegetation cover either by species or dominant species and species categories such as life form.

Production Measurement. Production is a measure of plant biomass yielded on a unit area. Production measurement can be accomplished by various techniques such as double sampling and harvesting method. Data can be recorded by species, dominant species or species categories such as life form.

Density Measurement. This parameter is a measure of the number of plants per given area (plot). Only those plants that are rooted within the plot are counted. If a plant is more than half in the plot it is counted. If more than half of the plant lies outside the plot it is not counted.

Species Diversity. Species diversity can be related to species number, community stability and the areal extent of the community under consideration. Measuring diversity of a community can be partitioned into categories such as life form. The Shannon- Weiner Diversity Index can be used to measure diversity. This equation provides a measure of species richness and organization within a vegetative community. Cover or production data is used in the Shannon-Weiner Index as shown in Table 1.

Sample Adequacy. Sample adequacy must be addressed in the evaluation of revegetation success to ensure that representative cover and production are used in the evaluation process. The equation suggested is shown in Table 2. A 90 percent and an 80 percent statistical confidence will be used for grassland and shrubland, respectively. Grassland is defined as a vegetation type or range site where shrub plus subshrub cover is less than 30 percent of the total vegetation cover, whereas shrubland is where shrub plus subshrub cover is 30 percent or more of the total vegetation cover. In no case should less than 10 quadrats or transects be measured in each area sampled. If sample adequacy is not met with this minimum number of samples, more randomly located quadrats or transects should be measured until adequacy is met.

The number of samples needed is determined separately for the reclaimed and reference areas.

Evaluation of Revegetation Success. The success of revegetation will be measured based on the ground cover and production. Cover and production will equal or exceed the standard for the last two consecutive years of the liability period. The cover and production shall be considered equal if they are at least 90

TABLE 1. SHANNON-WEINER DIVERSITY INDEX

$$H' = -\Sigma p_i \log p_i$$

H' = the diversity index

$p_i = N_i/N$

N_i = the cover for species i

N = the sum of all species cover

Source: Larson, 1980.

TABLE 2. SAMPLE ADEQUACY EQUATION

$$N_{min} = \frac{(st)^2}{(d\bar{x})^2}$$

N_{min} = minimum number of transects needed

s = sample standard deviation

t = the t-statistic*

d = amount of reduction desired to detect (0.1 to be within 10% of the true mean)

$\bar{x}$ = sample mean

*The Student's t-Distribution is used on small samples (30 or less) and for large samples (31 or more), a Z Distribution is used.

Source: Bonham, 1980.

percent of the cover and production of the reference or control area. This is measured when adequacy is met. The evaluation will require a statistical test only when the revegetated area is less than the mean for the standard. Otherwise, no statistical test is needed if the reclaimed mean is greater than or equal to the standard. A t-test comparison, as shown in Table 3, can be used for statistical test. The t-test equation calculates an estimated value (t_e). The estimated value is compared to a tabular value to evaluate revegetation success. If the calculated statistic is less than or equal to the t-table value, revegetation success is confirmed. If t_e is greater than the t-table value, the revegetation effort is not yet successful.

Wastepile Slopes

Wastepile slopes will be graded not to exceed an incline greater than 3:1. One foot of topsoil will be emplaced. Furrows will be created by a heavy-duty disk with alternate disks removed. The contour furrows will have enough distance between crest and valley to trap precipitation and prevent runoff.

The reduction of slopes to 3:1 will decrease the area on top of the dumps. Accordingly, the dump top area contributing to ponding will be small. The dump tops will be graded to more gentle slopes and contour furrowed. The larger areas that will be subject to ponding will have permanent impoundments installed. The impoundments will be designed to provide water for livestock. Water erosion control measures, i.e., pitting, imprinting, contour furrowing will be implemented. Dump tops will be plated with one foot of topsoil.

The water runoff prevention measures will allow water to infiltrate the ground. This results in more available soil moisture for plants. Increased plant cover also decreases erosion. The 3:1 slopes will readily accommodate livestock movement throughout the reclaimed areas. Additionally, the 3:1 slopes with contour furrows will not require post reclamation maintenance.

TABLE 3. T-TEST EQUATION

$$t_e = \frac{\bar{x}_s - \bar{x}_r}{\sqrt{\frac{s^2}{n_s} + \frac{s^2}{n_r}}}$$

t_e = calculated estimate of t

$\bar{x}$ = weighted mean for the revegetated area (r) and reference area standard (s)

$\frac{s^2}{n}$ = weighted variance of the mean for the revegetated area (r) and reference area standard (s)

Source: Larson, 1980.

REFERENCES

Bonham, C.D. 1980. A Survey of Techniques for Measurement of Herbaceous and Shrub Production, Cover, and Diversity on Coal Lands in the West. Contract No. J7090435. Denver, CO: Office of Surface Mining.

Larson, L. 1980. The Concept of Species Diversity in the Evaluation of Revegetation Success. Denver, CO: Office of Surface Mining.